Diastolic filling reserve preservation using a semispherical dacron patch for repair of anteroapical left ventricular aneurysm

Hartmann, Rebecca ; Auf der Maur, Christoph ; Toggweiler, Stefan ; Brunner, Christian ; Jamshidi, Peiman ; Mueller, Xavier ; Tavakoli, Reza

Abstract: In postinfarction left ventricular aneurysm, abnormal geometry and desynchronized wall motion may cause a highly inefficient pump function. The traditional endoventricular patch plasty according to the Dor technique might result in a truncated and restrictive left ventricular cavity in small adults. We report a modified technique of left ventricular anteroapical aneurysm repair by using a semispherical reshaping patch to restore the left ventricular geometry.

DOI: https://doi.org/10.1016/j.athoracsur.2016.02.026

Diastolic filling reserve preservation using a semi-spherical dacron patch for repair of antero-apical left ventricular aneurysm

Running head: Remodeling of left ventricular aneurysm

Rebecca Hartmann[1] MD, Christoph Auf der Maur[2] MD, Stefan Toggweiler[2] MD,

Christian Brunner[3] MD, Peiman Jamshidi[2] MD, Xavier Mueller[1] MD, Reza Tavakoli[1,4] MD, PhD

1 Department of Cardiac Surgery, Canton Hospital Lucerne, Switzerland

2 Department of Cardiology, Canton Hospital Lucerne, Switzerland

3 Department of Intensive Care Medicine, Canton Hospital Lucerne, Switzerland

4 Institute of Veterinary Physiology and Zurich Center of Integrative Human Physiology, University of Zurich, Switzerland

Keywords: non-restrictive repair ventricular aneurysm

Word Count: 1496

Corresponding Author:

Reza Tavakoli MD, PhD

Department of Cardiac Surgery, Canton Hospital Lucerne

Spitalstrasse 16

6000 Lucerne, Switzerland

Tel. +41412054502

Fax: +41412054563

Email: reza.tavakoli@luks.ch

Abstract

In post-infarction left ventricular aneurysm abnormal geometry and desynchronized wall motion may cause a highly inefficient pump function. The traditional endo-ventricular patch plasty according to the Dor Technique might result in a truncated and restrictive left ventricular cavity in small size adults. We report a modified technique of left ventricular antero-apical aneurysm repair by using a semi-spherical reshaping patch to restore the left ventricular geometry.

Introduction

The normal left ventricular (LV) shape is a prolate spheroid, crucial for the optimal function of the LV (1). Moreover, myofibrils of the ventricle present three different spatial orientations, i.e. longitudinal, circumferential and helicoid (2). Respective clockwise and anticlockwise torsional movements of the helicoid myofibrils during systole and diastole provide for optimal ejection and filling of the ventricle (1). In post-infarction LV aneurysm abnormal geometry and desynchronized wall motion may cause a highly inefficient pump function. Since the pioneer reports in 1944 various surgical techniques have been devised to treat LV aneurysms (3). Patch ventriculoplasty has gained popularity since its independent introduction by Jatene (4) and Dor (5). Here we report a modified technique of LV antero-apical aneurysm repair by using a semi-spherical reshaping patch to restore the LV geometry.

A 72-year old woman (34 kg, 138 cm, body surface area 1.14 m^2) was referred to our institution for antero-apical myocardial infarction due to the occlusion of the proximal left anterior descending coronary artery (LAD). Ad hoc recanalization of the LAD was then performed. The left ventricular ejection fraction (LVEF) was estimated at 20%. The patient was re-admitted one month later for bi-ventricular decompensation. Assisted mechanical ventilation and administration of inotropes and diuretics were required to re-compensate the patient. Two-dimensional echocardiography showed a large antero-apical left ventricular aneurysm of 6 cm in diameter. In four-chamber view end-systolic and end-diastolic volumes measured 121 ml/m^2 and 150 ml/m^2 respectively, representing high indexed left ventricular volumes. These indexed volumes were obtained by dividing the values shown in Figures 1 A and B by the small body surface area of the patient. Our obtained indexed values in two projections correlated with the existence of severely abnormal volumes (6). The calculated ejection fraction (19%) showed a severe impairment of the LV function.

Technique

Given the small body size of the patient, the volume of the aneurysm represented a significant loss of the LV function. The residual volume of the left ventricle after virtual exclusion of the aneurysm according to the traditional patch repair seemed to result in a diastolic restriction.

At surgery, prior to a median sternotomy a pediatric intra-aortic balloon pump (IABP) was surgically implanted through the right iliac artery. The choice of the material and implantation route was justified by the small body size of the patient. Upon pericardium incision 100 ml of pericardial effusion were drained. Cardio-pulmonary bypass (CPB) was instituted between the ascending aorta and the venae cavae. The patient was cooled down to 32°C and the aorta was cross-clamped. Myocardial protection was achieved by intermittent antegrade cold blood cardioplegia. The 6 cm large, thin-walled antero-apical LV aneurysm was freed from its pericardial adhesions and opened longitudinally (Figure 2). After opening the aneurysm, it became clear that a traditional patch repair would result in a too small and thus restrictive residual left ventricular cavity, as expected from the preoperative echocardiography. In order to increase the diastolic filling reserve of the left ventricle, we decided to insert a semi-spherical dacron patch to reshape the LV apex. A Dacron tube Cardioroot 32 mm (Maquet, Rastatt, Germany) was cut longitudinally in half and the sinus part of it was sutured to the neck of the aneurysm with a 2-0 Prolene running

suture. In this way the oval shape of the LV was well restituted. After excising a strip of 2 cm redundant aneurysmal wall the remaining aneurysmal tissue was closed over the repair with a layer of running 2-0 Prolene suture paying attention not to compress and deform the patch (Figure 3). After hot-shot administration, the aortic clamp was removed, the patient rewarmed and weaned from the CPB, with the additional support of the IABP. The patient had an uneventful early recovery and the IABP could be removed on the third postoperative day. The early postoperative trans-thoracic echocardiography showed the patch in its apical position, and an improvement of the LVEF up to 50 %. The patient was discharged from the hospital four weeks after surgery in good condition, with no dyspnoea or palpitations.

Three months after surgery, the patient was in functional class NYHA I with compensated cardio-pulmonary status. Two-dimensional echocardiography showed indexed end-systolic and end-diastolic left ventricular volumes of 36 ml/m^2 and 62 ml/m^2 respectively with a calculated ejection fraction of 42% (Figure 1 C and D). The obtained value from the end-diastolic volume corresponds to a mild left ventricular dilatation.

Comments

The surgical treatment of LV aneurysm evolved from direct suture techniques until the 1980s to the patch ventriculoplasty techniques later on (3). The purpose of the later methods is to recreate the normal LV geometry so that myofibrils of healthy myocardium may regain optimal working conditions (4, 5). However, the post-repair LV volume has been reported to correlate with post-operative cardiac event-free outcome (7). Based on the normal range of indexed end-systolic volumes (22±7 ml/m^2) and end-diastolic volumes (52±13 ml/m^2) Di Donato and co-workers routinely use a balloon sizer of 50-60 ml to reshape the LV (8). In our patient, the traditional endo-ventricular patch plasty according to the Dor Technique would have resulted in a truncated and restrictive LV cavity. To circumvent this pitfall we decided to use a semi-spherical dacron patch obtained from the sinus part of a Cardio-Root graft. The uneventful recovery of the patient and the clinical status and echocardiographic indices three months post-operatively support our choice of the modification of the reconstructive endo-ventricular patch technique.

In addition to myocardial muscle mass loss following the myocardial infarction, the post-infarction fibrous aneurysmal sack impairs the left ventricular function not only by the huge forward volume loss but also by preventing the remaining myocardial muscle fibres from contracting efficiently. The use of a bulged-out dacron graft does not simply replace a fibrous aneurysmal by a synthetic sack. It might be speculated that the bulged-out dacron graft would help not only reducing the forward volume loss but also increasing the efficiency of contractions of the remaining myocardial muscle fibres due to a better spatial rearrangement. This speculation needs further investigation.

References

1. Adhyapak SM, Parachuri VR. Architecture of the left ventricle: insights for optimal surgical ventricular restoration. Heart Fail Rev. 2010, 15(1):73-83. doi: 10.1007/s10741-10009-19151-10740.
2. Torrent-Guasp F, Ballester M, Buckberg GD, et al. Spatial orientation of the ventricular muscle band: physiologic contribution and surgical implications. J Thorac Cardiovasc Surg. 2001, 122(2):389-392.
3. Mukaddirov M, Demaria RG, Perrault LP, Frapier JM, Albat B. Reconstructive surgery of postinfarction left ventricular aneurysms: techniques and unsolved problems. Eur J Cardiothorac Surg. 2008, 34(2):256-261. doi: 210.1016/j.ejcts.2008.1003.1061. Epub 2008 May 1013.
4. Jatene A. Left ventricular aneurysmectomy. Resection or reconstruction. J Thorac Cardiovasc Surg 1985, 89: 321-331.
5. DorV, Saab M, Coste P, Korrnaszewska M, Montiglio F. Left ventricular aneurysm: a new surgical approa ch. Thorac Cardiovasc Surg 1989, 37: 11-19.
6. Lang RM, Badano LP, Mor-Avi V, Afilalo J, Armstrong A, Ernande L, Flachskampf FA, Foster E, Goldstein SA, Kuznetsova T, Lancellotti P, Muraru D, Picard MH, Rietzschel ER, Rudski L, Spencer KT, Tsang W, Voigt JU. Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J Am Soc Echocardiogr 2015, 28:1-39.
7. Di Donato M, Castelvecchio S, Menicanti L. End-systolic volume following surgical ventricular reconstruction impacts survival in patients with ischemic dilated cardiomyopathy. Eur J Heart Fail 2010, 12: 375-381.
8. DiDonato M, Castelvecchio S, Menicanti L. Surgical treatment of ischemic heart failure -The Dor procedure-. Circ J 2009, 73: Suppl A: 1-5.

Legend for figures

Figure 1.
Four-chamber view transthoracic echocardiography. Pre-operative large antero-apical LV aneurysm and severely abnormal end-systolic (A) and end-diastolic (B) as well as post-operative end-systolic (C) and end-diastolic (D) volumes at 3 months. Note the normal left ventricular geometry with mildly increased size.

Figure 2.
Intra-operative view of the large antero-apical LV aneurysm.

Figure 3.
Schematic representation of the operative technique.

Figure 1A

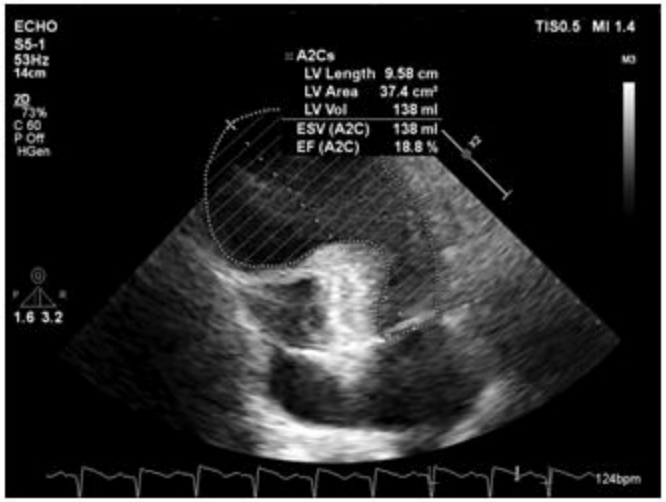


Figure 1B

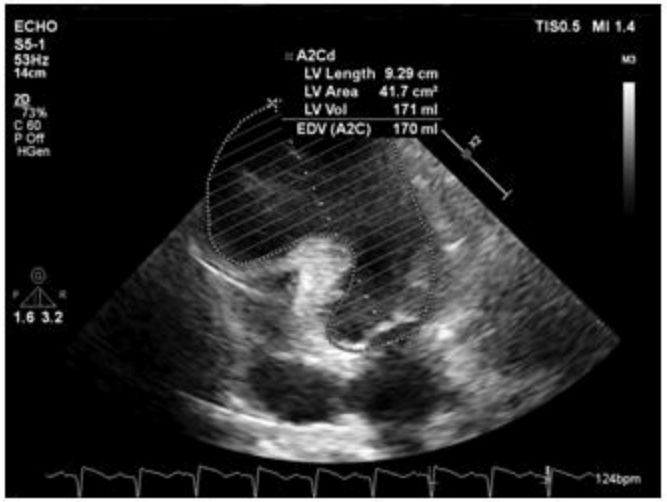


Figure 1C

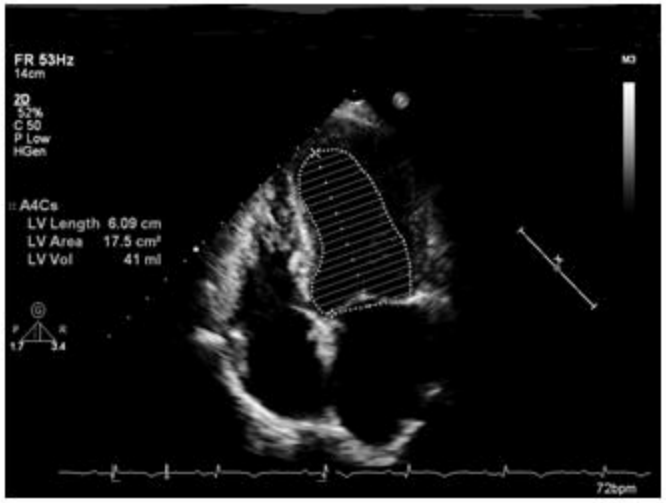


Figure 1D

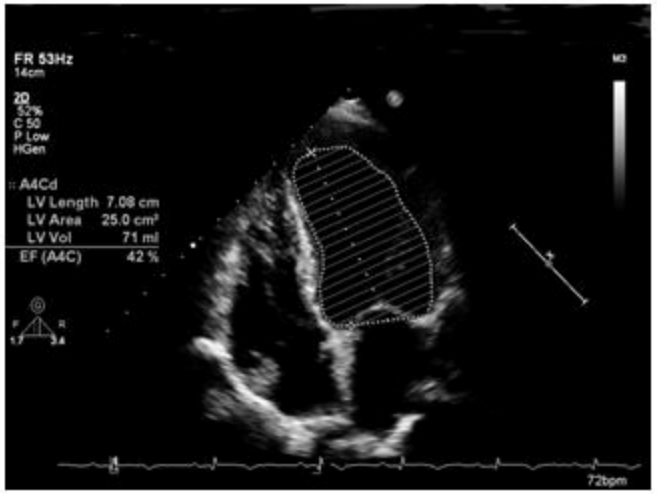
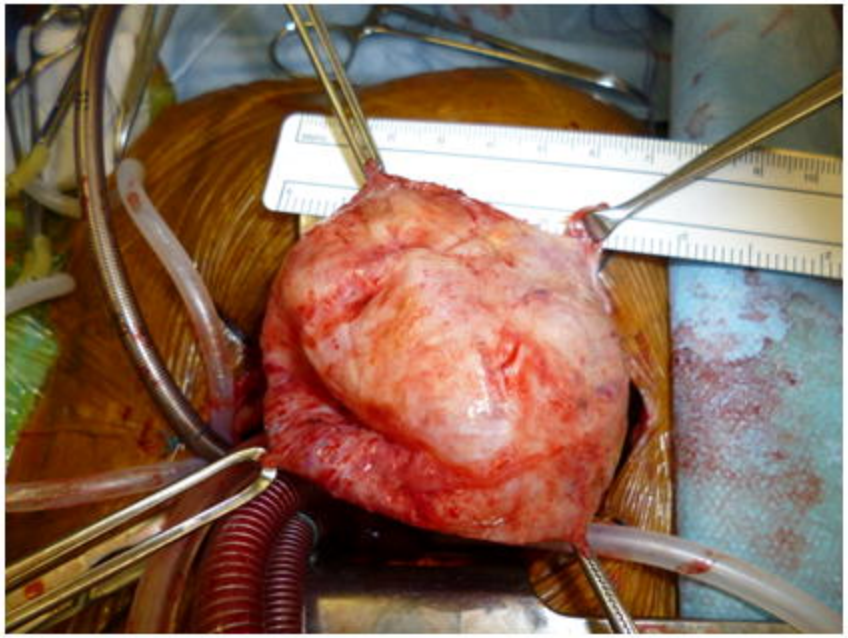


Figure 2



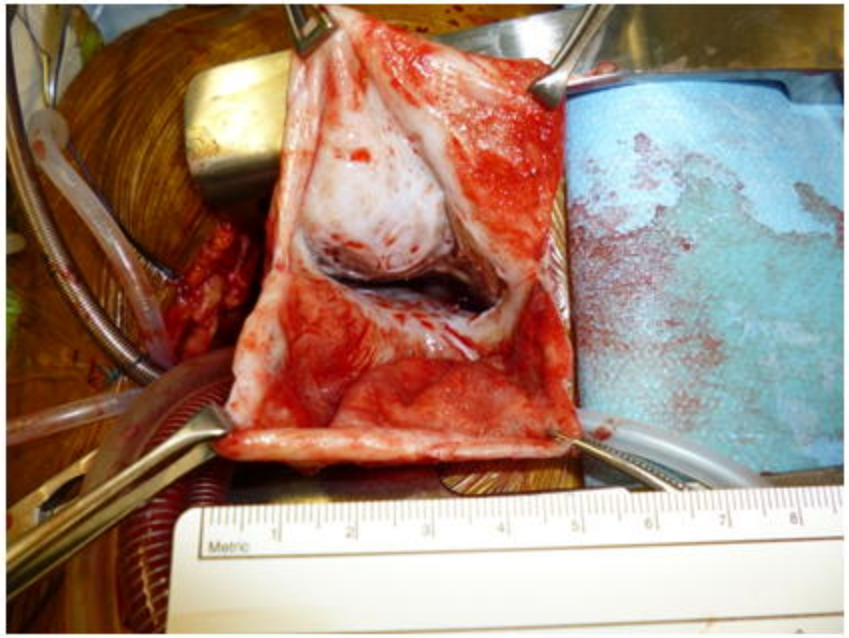


Figure 3